THE

Malayan Agricultural Journal.

Vol. XIV.] NOVEMBER, 1926. [No. 11

FURTHER RESULTS OF YIELDS OF RUBBER FROM BUD-GRAFTED TREES ON KAJANG ESTATE, SUNGEI REKO DIVISION.

F. G. Spring.

Major Gough very kindly placed an area of bud-grafted trees on Kajang Estate, Sungei Reko Division, at the disposal of the officers of the Department of Agriculture, S.S. and F.M.S. in the latter part of the year 1925.

The first records of yields of dry rubber from certain trees of Clone 1 and mixed Clones Nos. 1 and 9 were taken during December, 1925 and January, 1926 and published in the Malayan Agricultural Journal, Vol. XIV, No. 2, Feb. 1926. Further readings from trees of clone 1 and clone 9 were commenced on the 21st of September, 1926, and these results are given in this article.

Mother Trees.—No records of yields of the mother trees from which buds were taken (selected from trees on Kajang Estate) were kept but they were known as having given very high yields for a number of years. The trees were 13 years old when used for budding purposes. Major Gough informs me that each mother tree showed latex vessels much above the average.

Stock.—The source of seed was miscellaneous. They were not selected in any way. The seeds were planted in the field, at stake, and the budding of them began when they were one year old.

Bud grafted Rubber.—The field in which the two Clones are situated is approximately 40 acres in extent. The land was opened up from virgin jungle and most of the timber cleared previous to planting. The ground is undulating and the soil a light clay loam. Centrosema Plumieri was planted in the early stages of development of the property and a system of catch pits put in with the result that there has been little or no soil erosion.

Budding in the field commenced in October and November, 1921. The time from cutting back the seedlings up to the end of September, 1926, is approximately 4 years and 10 months. Distance of planting 20 ft. by 20 ft. = 108 trees to the acre.

No. of trees tapped per coolie = 310. Tapping commenced at 6-15 a.m. The same coolie (a Chinese man) taps all the experimental trees.

System of Tapping of Clone 9.

Tapping commenced in the last week in August, 1925, on a half spiral cut opened at a height of 20 inches from the ground which was continued daily for five and a half weeks and rested for a similar period. On November 8th, 1925, the half spiral left cut was reopened and the system of tapping was changed to alternate day. About 5 inches of bark were removed on this panel when tapping was discontinued. Subsequent tapping (alternate day) was commenced on the opposite panel at a height of 40 inches from the ground in the first week of June, 1926 and approximately 4½ inches of bark were consumed by 12th October, 1926.

System of Tapping Clone 1.

Trees Nos. 468, 467, 412, 408, 406, 471 and 469 were tapped on the same system as trees of clone 9. Trees Nos. 413, 391, 392, 337, 474, 473 and 472 were tapped as follows. A half spiral cut was opened at a height of 20 inches from the ground and on 12th October, 1926 about 9 inches of bark were removed. Tapping was conducted on alternate days.

Twelve records of yields were made by the writer, who visited the estate on each occasion and himself collected and coagulated the latex. The rubber was subsequently weighed at the office of the Department of Agriculture, F.M.S. & S.S., Kuala Lumpur. Tapping was not conducted for the purpose of enabling the writer to take records. The writer visited according to his own convenience and took records from the trees mentioned in the tables on the dates given.

The 23 test trees from which records were taken constitute all the trees of Clone 9 which were known at the time. The first test yields from trees Nos. 584, 287, 220 and 170 were recorded in the previous article.

Average girth at 17″ from ground of trees in Clone 5 on 21-9-26 = 24.4″

Average girth at 17″ from ground of trees in Clone 1 on 12-10-26 = 23.6″

Average girth at 39.37″ from ground of trees in Clone 9 on 21-9-26 = 23.0″

Average girth at 39.37″ from ground of trees in Clone 1 on 12-10-26=22.0″

The measurements of girth given for trees of Clone 9, show that the girth at 39.37 inches and at 17 inches are very nearly the same, an average of 23.0 inches, against an average of 24.4 inches, a difference of 1.4 inches showing that the girth of these trees at nearly ground level and at 40 inches is very nearly equal.

In Clone 1, the average girth at 39.37 inches is 22.0 inches and at 17 inches 23.6 inches, a difference of 1.6 inches.

Yields of Dry Rubber from Test Trees in Clone 9.

Average yield per tree from 23 trees on 14-8-26=29.1 grms.
Average yield per tree from 23 trees on 18-8-26=25.5 grms.
Average yield per tree from 23 trees on 9-9-26=32.5 grms.
Average yield per tree from 23 trees on 15-9-26=30.4 grms.
Average yield per tree from 23 trees on 17-9-26=28.4 grms.
Average yield per tree from 23 trees on 21-9-26=30.8 grms.

Yields of Latex in c.c. from Test Trees of Clone 1.

Average yield per tree from 15 trees on 14-8-26=109 c.c.
Average yield per tree from 15 trees on 18-8-26=100 c.c.
Average yield per tree from 15 trees on 9-9-26=101 c.c.
Average yield per tree from 15 trees on 15-9-26= 90 c.c.
Average yield per tree from 15 trees on 17-9-26= 82 c.c.
Average yield per tree from 15 trees on 21-9-26= 95 c.c.

Clone 9.—The highest average yield in Clone 9, is from tree No. 603 giving 37.0 grms. of dry rubber, per tapping. The poorest yielder is tree No. 358 giving 21.8 grms. of dry rubber, per tapping.

Clone 1.—The highest average yield in those trees of Clone 1 which were included in these tests is from tree No. 337 giving 152 c.c. per tapping. The poorest yielder is tree No. 392 giving 52 c.c. per tapping.

The trees of both groups were tapped on the same dates.

The following yields per acre, per annum, are calculated on 160 tapping days at 80 trees to the acre.

5 grms. per tree per tapping= 141 lbs. per acre per annum.
10 grms. per tree per tapping= 282 lbs. per acre per annum.
15 grms. per tree per tapping= 423 lbs. per acre per annum.
20 grms. per tree per tapping= 564 lbs. per acre per annum.
25 grms. per tree per tapping= 705 lbs. per acre per annum.
30 grms. per tree per tapping= 846 lbs. per acre per annum.
35 grms. per tree per tapping= 988 lbs. per acre per annum.
40 grms. per tree per tapping=1128 lbs. per acre per annum.

The average yield of dry rubber per tree, per tapping, from trees Nos. 584, 287, 220 and 170 over the first test period (16-12-25 to 7-1-26) is 15.8 grms., 21.6 grms., 19.6 grms. and 16.9 grms. During the second period (14-8-26 to 21-9-26) the average yields from these trees were 31.6 grms., 32 grms., 26.9 grms. and 34.2 grms. per tree, per tapping, an increase over the first period of 15.8 grms., 10.4 grms. 7.3 grms. and 17.3 grms. This increase in about eight months is very high and it is not to be expected that this proportional rise in production can be continued. It will be seen from the figures that the dry weights of rubber obtained from all the trees of Clone 9 are remarkably high, an average of approximately 30 grms. of dry rubber per tree, per tapping.

Received for publication 12th November, 1926.

Table I.

Yield from Bud-grafted trees on Kajang Estate, Sungei Reko Division.

Clone 9.

Tree No.	Girth at 39.37. ins. on 21.9.26	Girth at 17 ins. on 21.9.26	Yield of Latex in c.c. on 14.8.26	Dry Weight of rubber in grms.	Yield of latex in c.c. on 18.8.26	Dry weight of rubber in grms.	Yield of latex in c.c. on 9.9.26	Dry weight of rubber in grms.	Yield of latex in c.c. on 15.9.26	Dry weight of rubber in grms.	Yield of latex in c.c. on 17.9.26	Dry weight of rubber in grms.	Yield of latex in c.c. on 21.9.26	Dry weight of rubber in grms.	Average dry weight of rubber in grms. per tapping.
220	21.1	22.5	78	18.9	91	23.3	124	33.3	120	30.5	93	24.4	116	31.2	26.9
223	23.3	23.9	100	27.4	80	22.4	103	30.5	93	27.0	lost	...	97	29.0	27.2
229	24.5	26.0	124	30.8	77	18.5	100	28 0	95	26.5	105	28 8	98	27.3	26.6
288	22.0	23.6	120	30.7	110	25.0	84	27.0	84	25.2	83	23.0	94	29.1	26.6
287	23.9	25.0	114	31.9	93	27.0	110	33.1	127	38.2	83	26.1	115	36.1	32 0
300	22.1	23.8	120	33.2	88	26.8	111	34.5	90	29.1	80	24.9	99	29.0	29.5
357	25.7	26.1	118	37.5	108	33.9	102	35.6	107	37.4	spilt	...	124	25.2	33.9
426	22.9	24 2	78	21.6	115	32.2	172	46 6	139	36 9	116	31.2	109	30.3	33.1
427	20.6	22.5	98	24.1	73	19.4	115	29.5	101	25.6	93	23.7	100	42 4	27.4
429	23.0	25.1	83	23 4	79	21.5	88	25.6	103	29.4	101	28 3	110	31.0	26.5
451	22.8	24.4	102	26.1	111	27.5	120	31.3	81	21.2	116	30.3	...	28.1	27.4
509	25.6	27.0	112	36 7	88	27.6	93	32.4	90	32.1	93	33 0	90	32.5	32.3

TABLE I.—(*cont.*).

Yield from Bud-grafted trees on Kajang Estate, Sungei Reko Division.

CLONE 9.

Tree No.	Girth at 39.37 ins. on 21.9.26	Girth at 17 ins. on 21.9.26	Yield of latex in c.c. on 14.8 26	Dry weight of rubber in grms.	Yield of latex in c. c. on 18.8.26	Dry weight of rubber in grms.	Yield of latex in c. c. on 9.9.26	Dry weight of rubber in grms.	Yield of latex in c. c. on 15.9.26	Dry weight of rubber in grms.	Yield of latex in c. c on 17.9.26	Dry weight of rubber in grms.	Yield of latex in c. c. on 21.9.26	Dry weight of rubber in grms.	Average dry weight of rubber in grms. per tapping.
520	23.7	24.9	101	28.3	94	27.8	122	34.9	117	33.8	98	27.5	...	...	30.4
561	22.8	24.2	102	26.0	98	25.1	110	30.8	110	31.0	122	33.1	100	28.4	29.0
583	21.3	22.1	75	18 5	66	17.1	112	30.4	112	24.8	80	20.6	94	24.9	22.7
584	22.2	24.0	156	34.8	130	28 5	147	32.7	142	32.2	122	29.6	130	31.8	31.6
603	23.0	25.3	143	38.3	134	35.2	130	38.5	108	34 0	129	38.7	121	37.6	37.0
361	20.8	22.2	82	23 2	72	21.0	63	20.0	80	24.7	70	21.9	91	27.3	23.0
358	22.5	24.2	82	22.0	74	19.0	90	23.8	90	24.8	77	20.2	80	21.3	21.8
286	23.7	24.1	163	38.3	132	31.7	150	38.4	122	33.1	138	36 6	120	30.9	34.8
226	24.8	26.0	93	30.0	88	28.0	98	32.0	94	31.6	85	28.5	85	29.4	29.9
170	24.5	26.1	141	34.4	96	24.7	138	41.7	106	33.7	130	40.1	98	31.1	34.2
167	22.6	24.3	141	33.5	108	25.2	145	37.0	146	38.0	100	26.8	174	45.5	34.3
Averages	23.0	24.4	110	29.1	95	25.5	114	32.5	106	30.4	100	28.4	106	30.8	...

TABLE II.

Yield from Bud-grafted trees on Kajang Estate, Sungei Reko Division.

CLONE 1.

Tree No.	Girth at 39.37 ins. on 12.10.26.	Girth at 17 ins. on 12.10.26.	Yield of latex in c.c. on 14.8.26.	Yield of latex in c.c. on 18 8.26.	Yield of latex in c.c. on 9.9.26.	Yield of latex in c.c. on 15.9.26.	Yield of latex in c.c. on 17.9.26.	Yield of latex in c.c. on 21.9.26.	Averages.
468	21.0 ins.	22.8 ins.	108	80	92	90	80	90	90
467	22.6 „	25.4 „	137	130	130	118	80	110	117
412	20.9 „	23.2 „	157	142	110	115	70	81	112
413	23.9 „	25.0 „	85	72	74	68	62	52	68
391	24.5 „	25.2 „	68	66	75	72	80	85	74
392	22.0 „	22.9 „	50	40	60	45	58	60	52
337	24.8 „	26.8 „	170	180	142	140	140	144	152
408	22.1 „	22.9 „	60	66	68	60	62	68	64
406	24.7 „	26.6 „	170	—	130	125	110	156	138
407	19.6 „	21.4 „	60	—	59	42	51	61	54
474	20.2 „	21.6 „	89	76	96	64	86	92	83
473	20.5 „	21.7 „	121	106	120	95	90	102	105
472	22.2 „	23.2 „	128	134	135	120	94	123	122
471	19.3 „	20.5 „	100	93	121	102	75	127	103
469	23.0 „	24.9 „	132	120	114	98	93	85	107
Averages.	22.0 „	23.6 „	109	100	101	90	82	95	

NOTE—Only Volume of latex was taken from this clone.

CHINESE WOOD OIL AND CANDLENUT OIL.

B. J. Eaton and C. D. V. Georgi.

Introduction.

Enquiries are received occasionally regarding the differences between Chinese Wood oil and Candlenut oil, both of which oils are obtained from Seeds of *Aleurites* species.

Chinese wood oil, known also as Chinese Tung oil, is prepared principally from seeds of *Aleurites Fordii*, Hemsl., although it appears that a certain quantity of oil from *Aleurites montana*, Wils. comes on the market under this name. Candlenut oil is obtained only from seeds of *Aleurites triloba* (syn. *A. moluccana*).

A botanical description of these species of *Aleurites* and a short account of their distribution has already been published in this Journal, compare "Candlenut and Chinese Wood Oil Trees" by W. N. Sands, Vol. XII, No. 1, January 1924, page 1.

Three samples of genuine Chinese Wood oil have recently been received through the kind agencies of H.B.M. Consuls-General at Shanghai and Hankow and it has therefore been possible to determine some of the more important constants of this oil and compare them with the constants of candlenut oil. The sample of candlenut oil used in these experiments was prepared from a consignment of nuts forwarded by Mr. A. M. Tuke, Kota Tampan Estate, Lenggong, Upper Perak.

Special Characteristic of Chinese Wood Oil.

It is well known that both Chinese Wood oil and candlenut oil are drying oils, and therefore are possible substitutes for linseed oil, although as regards actual drying properties they are both inferior to the latter oil.

There is one particular test by which it is possible to distinguish between Chinese Wood oil and candlenut oil, and detect with a considerable degree of accuracy the addition of small quantities of the latter to the former oil.

This test is known as the gelatinisation test and consists in heating the oil to a high temperature, maintaining it at this temperature during a short interval, when rapid gelatinisation takes place. This sudden change which the oil undergoes is probably due to the polymerisation of the glycerides present in the oil.

There are one or two modifications of this test; that employed in the present series of experiments being known as Worstall's test, which is also the test usually adopted in China for determining the quality of Chinese Wood oil.

The details of this test are as follows:—100 grammes of oil are weighed into a nickel basin, 4½ inches in diameter. The oil is then heated as rapidly as possible by means of a large gas burner to a temperature of 282°C, a thermometer being suspended in the middle of the oil, and the oil stirred during the operation. The time taken to reach this temperature is determined by means of a stop watch; it is usually about 4 minutes and must not exceed 4½ minutes. When comparing different samples of oil it is important to ensure that the duration of heating is the same in all cases. When the required temperature has been reached, the stop watch is re-started and the flame adjusted so as to maintain the oil at the above temperature, which should not vary more than 279°C—285°C. The oil is stirred constantly. When the oil begins to thicken and a skin forms on the surface the time on the stop watch is noted, and the oil is then stirred vigorously until it has become quite solid. The solidified cake is allowed to remain in the basin for a minute, then placed on a tile and cut with a knife. Pure Chinese Wood oil gives a cake which is pale in colour, firm in texture and cuts smoothly like new bread, not sticking to the knife. Further, the time from the attainment of the temperature of 282°C to the formation of the skin must not be longer than 7½ minutes. If more than 7½ minutes or if the solidified cake is soft or sticky, adulteration is suspected.

Results of Analysis.

The following table gives the results of analysis of the various samples together with the details of the specification in respect of these constants as required by the oil exporters in China.

Constant.	Specification.	Sample A	Sample B	Sample C	Candlenut Oil.
Acidity, Oleic Acid per cent	3.0 (average)	3.5	1.5	2.2	1.7
Iodine value (Wijs)	155-170	168.5	170.3	170 0	158 5
Worstall's Test	Maximum time 7½ mins.	7¼ mins.	6 mins.	6¼ mins.	Remained liquid.

Remarks and Conclusions.

From the above results it will be seen that, of the three samples of Chinese Wood oil, two conform to the specification laid down, while the third sample shows a slight excess of acidity. In this connection, the slight excess in the figure for the Iodine value of sample "B" is considered insignificant.

It will be noticed that, while all the samples of Chinese Wood oil satisfied the requirements of Worstall's test, candlenut oil failed to pass this test, and further the Iodine value of the Chinese Wood oil is higher than that of candlenut oil by about 6-7 per cent.

In order to ascertain to what extent the presence of candlenut oil in a sample of Chinese Wood oil would be revealed by Worstall's test, these two oils were mixed in the proportions shown in the table below and the resultant oil tested in the usual way. The results of the experiments were as follows:—

Proportions of oils in mixture.	Duration of heating to formation of skin.	Remarks.
Chinese Wood oil 95 parts Candlenut oil 5 parts	8¼ mins.	Cake firm, but dark and sticky.
Chinese Wood oil 90 parts Candlenut oil 10 parts	9¼ mins.	Cake soft, dark and very sticky.

It will be seen from these experiments that the presence of a relatively small proportion of candlenut oil is readily shown by this test, which is such an important criterion of the purity of Chinese Wood oil.

In conclusion the writers wish to express their appreciation of the assistance of H.B.M. Consuls-General at Shanghai and Hankow, both in arranging for the supply of the samples of oil, and also for much of the other information, including the details of the Worstall's test, contained in this article.

Received for publication 7th October 1926.

Note:—Since carrying out this work, it is noted that an investigation on a modification and extension of Worstall's test for determining the adulteration of Chinese Wood oil has been carried out by Messrs Bolton & Williams (Analyst Vol. LI, No. 604, July 1926, page 335).

A BRIEF SUMMARY OF TAPIOCA CULTIVATION ON WHAT IS NOW A VALUABLE RUBBER ESTATE IN PROVINCE WELLESLEY.

F. Birkinshaw.

Preliminary Remarks.

In Malaya there is a general opinion that the cultivation of Tapioca has a very exhaustive effect upon the soil. It is certainly a fact that many areas of land which were formerly under Tapioca are now less fertile as a result, in the sense that the soil produces less luxuriant plant growth. This fact, however, does not necessarily imply that the decreased fertility is caused solely by the removal of quantities of plant food from the soil by the Tapioca plant. It may be due to a greater or less extent to other causes connected with methods of cultivation, as, for instance, heavy wash on hilly lands.

A fact, that is perhaps less well known than the general opinion alluded to above, is that certain areas of land now covered with well grown Rubber have previously carried successive crops of Tapioca over a long period.

This fact led the Secretary for Agriculture* some time ago to suggest the advisability of obtaining reliable information regarding the methods of cultivation of Tapioca on one such area. In accordance with this suggestion the information which follows was obtained from the Manager of a Rubber estate in Province Wellesley, on which Tapioca had been grown continually for a long period, both previous to the Malaya Rubber planting era and afterwards as a catch crop amongst the young Rubber.

Soil and Methods of Cultivation.

The soil on the estate in question, being a deep loam with a clay sub-soil, may be considered as eminently suitable for the crop, provided it is efficiently drained; for Tapioca is impatient of water-logged soil and cannot stand flooding, even for a short period.

The land is flat and, the Tapioca being planted on banks, soil-wash was never a serious problem and it may be taken for granted that very little occurred.

---

*Mr. A. S. Haynes.

Tapioca was cultivated continuously for a great many crops, that is to say, no system of fallowing was followed, although there were occasional instances where a period of varying length would elapse between the reaping of one crop and the planting of another on the same area. This was governed by the availability or otherwise of labour and was in no sense any attempt at a system of fallowing.

On virgin land the tubers were coarse and of a high water content, so did not yield the best quality flour or flake. The quality improved with each crop, the best flour or flake being obtained from the older crops.

The average yield was approximately 150 pikuls an acre. When the yield tended to fall below this amount manuring was resorted to. It was generally found that manuring became necessary after the fourth successive crop.

The manures in general use were potassium nitrate, ammonium sulphate and bonemeal. These were usually mixed with sand to make even distribution easy.

Tillage before planting each crop was thorough, the land being double changkolled and all weeds and grass turned under. Weeding was attended to in the early stages of growth.

The crop was ready for harvesting in from 10 to 12 months from planting, varying according to the number of crops which had been taken off the land, the first crop from virgin land requiring the longest period to mature.

Brief History of the Estate.

The estate in question was opened as a Tapioca estate excepting for a small area where Sugar preceded Tapioca.

Later, Coconuts were planted as a permanent crop over a limited area and still later Rubber became the permanent crop practically over the whole of the Estate.

Avenue planting was the method decided upon for the Rubber at 30 feet between the rows, as this conveniently allowed the Tapioca to be retained as a catch crop, five rows of the latter being planted on banks at five feet apart between the avenues of Rubber. The system of manuring the Tapioca was continued for so long as the crop was grown.

Whilst the Rubber was still young, care was taken that the catch crop did not smother the permanent one: the stalks and leaves of the Tapioca nearest the Rubber plants being lopped wherever necessary.

There are parts of the Estate in question, now carrying a stand of excellent Rubber, which have produced 15 continuous crops of Tapioca.

One field on the Estate which the writer visited contains some of the best ten year old Rubber to be found in Province Wellesley. This field produced four crops of Tapioca prior to 1900 when Coconuts were planted, the Tapioca being continued as a catch crop for another 8 crops. The Rubber was planted in 1916 and is now giving 400 lbs. an acre on alternate day tapping on a V.

On another field 5 crops of Tapioca were produced as a catch crop after the Rubber was planted. Trees were first tapped in 1910. This field, too, has produced 400 lbs. to the acre and has just recently been put out of tapping for a rest for the first time.

Summary.

Facts of the cultivation methods and history of Tapioca on what is now a valuable Rubber estate are given. These facts have been supplied by the manager of the estate in question, both from personal knowledge and from records on the estate. The cultivation methods consisted of thorough tillage between the harvesting and planting of crops, vegetation being buried in the process, and a continuous system of manuring begun when the Tapioca showed signs of needing manure, generally after the fourth crop.

The past history of the estate shows that the land on the estate produced a great many continuous crops of Tapioca, on some areas up to 15 crops. The present history is that the estate is a valuable Rubber property having an uniform stand of well developed, good yielding trees.

Conclusions.

It would appear that the facts given above leave no room for doubt that under certain conditions of soil, contour, tillage and manuring it is possible for land to produce a large number of continuous crops of Tapioca without any appreciable detrimental effect on the subsequent growth of the Rubber tree.

In conclusion I wish to express my sincere thanks to the Manager of the Estate both for the information given and the help he subsequently gave in correcting mistakes made in earlier drafts of this short aritcle.

Below are tabulated comparative figures of Tapioca factory work on the Estate:—

Year.	Pikuls of Roots Milled.	Pikuls of Flour Manufactured.	Percentage of Flour Obtained.	Pikuls of Roots to 1 Pikul of Flour.
1910	70,109	11,899	16 97	5 88
1911	40,500	6,273	15 48	6.45
1912	88,921	13,306	14 96	6 68
1913	51,736	7,751	14.99	6.66

Received for publication 25th June 1926.

MANURING OF RUBBER ESTATES.

B. J. Eaton and F. G. Spring.

Many enquiries have been received recently regarding the manuring of rubber trees, especially on areas on which the yields are poor. Apart from the very successful results obtained on a certain type of soil on the estates of the Holland American Plantation Maatschaapij in Sumatra, little information is available on results obtained by the application of artificial fertilizers to rubber cultivation. In these experiments, in which phosphates, potash salts and nitrogenous fertilizers were applied, increases in yield were obtained only from plots to which soluble nitrogenous fertilizers, especially ammonium sulphate and nitrates (of calcium or sodium) were applied.

It must be borne in mind also that results obtained on one type of soil may not apply generally. On this account, before recommending the wholesale application of any artificial fertilizer which may have no effect and may thus result in a large financial loss, it is advisable first to carry out experimental field trials on small areas.

The object of this article is to describe a suitable method of experiment and to give information and advice in the case of both hilly and flat land. In a complete fertilizer experiment it is necessary to apply compounds containing nitrogen, potash and phosphates, which are the principal plant constituents usually deficient in soils in addition to lime.

Apart from the fact that these must be applied singly and in combination in order to ascertain whether the particular soil is deficient in one or more constituent, it is also necessary subsequently to ascertain the most economical and suitable compound containing the deficient constituent.

Thus, nitrogen may be applied in the form of cattle manure, cakes or meals from various oil seeds, bloodmeal, nitrogenous guano or one of the numerous nitrogenous artificial fertilizers—ammonium sulphate, sodium, potassium or calcium nitrate, calcium cyanamide, urea, or ammonium

phosphate; phosphates may be applied in the form of basic slag, finely ground mineral phosphates, guano, or as superphosphate, while potash may be applied in the form of sulphate or chloride (muriate) of potash. In addition, some of these fertilizers may be found more effective, after lime has also been applied to the soil.

Experiments of this kind, in which all of the most important plant foods are tried are generally too complicated for the average estate, especially in the case of rubber cultivation. In cases where only the annual collection of a cereal or root crop is concerned, the conditions are simplified, since only one record per plot is required viz. the total crop harvested at a particular date from the manured and untreated plots. In the case of rubber, it is essential to take records of yields periodically over at least one complete year and perferably over two years, since, in some cases, the effect of manuring may not be felt till a year after the fertilizer has been applied.

In view of the facts that (a) experience in connection with Malayan soils has shown that loss of humus and nitrogen has occurred, due in some cases to a long history of previous cultivation, especially with gambier, tapioca, pineapples or pepper, and (b) erosion on hill soils due to lack of proper methods of soil conservation also causes loss of humus and nitrogen, it is considered that the application of nitrogenous fertilizers is of the greatest importance.

Further, the amount of potash in Malayan soils is generally adequate while the amount of phosphoric acid is low and, apart from the maintenance of the growth and health of the rubber tree, only a very small amount of plant food constituents is removed annually from the soil in the latex collected and the bark excised. On account of these facts, it is considered preferable to concentrate on the application of soluble and readily absorbed nitrogenous fertilizers, such as sulphate of ammonia and or nitrate of soda.

It appears from the very successful experiments carried out in Sumatra that sulphate of ammonia is as effective as nitrate of soda, so that a choice of these two fertilizers will depend on their relative cost, bearing in mind the fact that 4 lbs. of sulphate of ammonia (20-21 per cent. of nitrogen) is equivalent in nitrogen content to 5 lbs. of nitrate of soda (16.4 per cent. of nitrogen). Although trials with phosphatic fertilizers (superphosphate is recommended since it is a soluble phosphatic fertilizer and therefore likely to be readily absorbed) in Sumatra, have shown that the application of phosphates is without effect, it is considered advisable to lay down experimental plots if possible.

In view of the fact that various grades of ammonium phosphate are now being manufactured in America and Germany, it was thought that this fertilizer would be an excellent source of both nitrogen and phosphorus. We have been informed however that extensive trials with this fertilizer have given no results in Sumatra on soils which respond to applications of ammonium sulphate. If however areas are not available on certain estates or it is not considered possible to experiment with both nitrogen and phosphates it is recommended that a similar scheme be adopted, substituting nitrate of soda for the superphosphate plots and omitting the plots on which both superphosphate and sulphate of ammonia are applied together. If sulphate of ammonia only is applied the manured and untreated plots may be equivalent to a coolie task and the coolies can be changed over weekly, or each plot can be equivalent to a half a coolie task, so that the same coolie can tap one manured and one untreated plot, in order to eliminate the coolie tapping error. It is preferable to select plots which are as uniform as possible and, where possible, to take preliminary records of yields from each plot before the fertilizers are applied. The object of duplicating the plots, as shown on the plan, is to eliminate or reduce any variations, if preliminary records are not available.

Apart from recording the yields after application of the fertilizer, it is also advisable to make notes on the girth, bark, foliage and general appearance of the trees from time to time, especially since fertilizers have a "residual" effect which may not be observed in the earlier stages in respect of yields.

Areas which will respond most readily to the application of fertilizers, especially soluble and readily absorbed nitrogenous fertilizers such as sulphate of ammonia or nitrate of soda are (a) light sandy soils (b) eroded soils from which the surface humus has been lost (c) soils with a long previous history of cultivation under crops such as gambier, tapioca or pineapples and (d) flat heavy clay soils in which ammonification and nitrification is absent. In the last instance, drainage, in addition to the application of the fertilizers, is essential. Two points appear to be of considerable importance viz. (a) removal of cover crops and grasses or weeds before the application of the fertilizer; if this is not done the cover crop, grass or weeds, which are surface feeders, absorb the fertilizer at the expense of the rubber tree, which does not benefit (b) the application of the fertilizer preferably during the wintering season.

Names and addresses of suppliers of artificial fertilizers, together with prices can be provided by the Department of Agriculture. The lay-out of experimental plots, together with details of experiments are given below:—

Plan of Manurial Experiment for Hill Land.

Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Plot 6	Plot 7	Plot 8	Plot 9	Plot 10	Plot 11	Plot 12
Sulphate of Ammonia	*Control*	Superphosphate	*Control*	Sulphate of Ammonia and Superphosphate	*Control*	Sulphate of Ammonia and Superphosphate	*Control*	Sulphate of Ammonia	*Control*	Superphosphate	*Control*

Plan of Manurial Experiment for Flat Land.

Plot 1 Sulphate of Ammonia	Plot 2 *Control.*	Plot 3 Superphosphate	Plot 4 *Control.*	Plot 5 Sulphate of Ammonia and Superphosphate	Plot 6 *Control.*
Plot 7 *Control.*	Plot 8 Sulphate of Ammonia and Superphosphate	Plot 9 *Control.*	Plot 10 Sulphate of Ammonia	Plot 11 *Control.*	Plot 12 Superphosphate

NOTES.

Area of each plot; one acre.—This enables 1 tapper to tap three plots, containing at least one control plot.

Rate of application of Manure.—Sulphate of Ammonia 4 cwts per acre.

Superphosphate 4 cwts per acre.

Method of application.—Broadcast over the land and changkol or fork in the manures to a depth of about 3 inches, the control plots to receive similar treatment, as regards tillage.

Time of application.—One application every two years, preferably during the wintering season.

Records.—The yields, from each plot, to be recorded at least twice a month, in dry weights of rubber. In the case of periodic tapping the yields should be taken more frequently; say once per week. Apart from these records, the total weight of rubber from each plot to be weighed monthly.

Cost of fertilizer and its application to be recorded.

Average girth increase to be recorded annually.

Tapping.—A similar system for each plot. The height of the cut from the ground, to be the same in each plot at the commencement of the experiment.

Labour.—Coolie A. taps plots 1, 2 and 3 the first month, plots 4, 5 and 6 the second month, 7, 8 and 9 the third month and 10, 11 and 12 the fourth and so on.

Coolie B. commences with plots 4, 5 and 6 the first month, plots 7, 8 and 9 the second month, and so on.

Coolie C. commences with plots 7, 8 and 9 the first month, 10, 11 and 12 the second month and so on.

Coolie D. commences with plots 10, 11 and 12 the first month, plots 1, 2 and 3 the second month and so on.

Collecting pails to be numbered to coincide with the number of the plot, and the dry rubber sample to be labelled similarly.

Division of Plot.—On flat land a trench of 2 feet depth between each plot, to avoid effect of fertilizer on outside rows of control plots. If two rows of trees can be left between each plot on flat land this is preferable to isolating the plots by a drain. On hill land, two rows of trees should be left between each plot and these should not be included in the experiment.

Hilly land.—Plots arranged in parallel, to avoid possible effect of wash and movement of fertilizer. (See sketch).

Received for publication 3rd November, 1926.

Note:—It may be emphasised here that although the results of chemical and physical analyses of soils are extremely useful as a guide, in connection with the cultivation of various crops, they are by no means absolute. Further the method of field experiment or trial plots alone can determine whether the application of chemical fertilizers or other treatment is likely to be economic. The economics of manuring also depends on the market value of the increased crop in relation to the cost of the fertilizer and its cost of application.

Further, in the case of permanent crops, the effect of manuring may have an influence over a long period and may not be shown until some time after application.

It is advisable if possible to have a duplication of this experiment in order to reduce or eliminate the experimental error and soil variations etc.

LONDON MARKET PRICE LIST, 3rd QUARTER 1926.

Oil Seeds.

Castor (Bombay)	-	£15.15.0	to	£17. 0.0	per ton.
Copra (Ceylon)	-	£30.15.0	to	£29.12.6	,,
Copra (Straits)	-	£28.10.0	to	£29.10.0	,,
Cotton Seed	-	£10.	to	£10. 2.6	,,
Desiccated Coconut (fine)	-	44/6			per cwt.
,, ,, (medium)	-	44/6			,,
,, ,, (coarse)	-	43/-			,,
Ground nut (Hull)	-	£22.17.6	to	£21.. 2.6	per ton.
Linseed (Bombay)	-	£19	to	£17 15.0	,,
,, (Plate)	-	£16.15.0	to	£17	,,
Palm Kernels (West African)	-	£20.12.6	to	£20. 2.6	,,

Oils.

Castor (First pressing)	-	£46	to	£43.10.0	,,
Coconut (Cochin)	-	£56			,,
,, (Ceylon)	-	£48	to	£47	,,
Cotton Seed (Egyption Crude)	-	£40	to	£37	,,
Ground nut (Crude)	-	£48	to	£44	,,
Linseed	-	£36	to	£32	,,
Palm (Lagos)	-	£38. 9.0			,,
Palm Kernel	-	£43.10.0	to	£41.10.0	,,

Oil Cakes.

Coconut	-	£ 8. 5.0	to	£ 9. 7.6	,,
Cotton (Egyptian seed)	-	£ 5.15.0	to	£ 5. 2.6	,,
,, (Bombay seed)	-	£ 5. 2.6	to	£ 5.10.0	,,
Ground nut (London decorticated)	-	£12. 0			,,
Linseed 9%	-	£11. 5.0	to	£11.10.0	,,
Palm Kernel	-	£ 6. 5.0	to	£ 7	,,

Essential Oils.

Cajeput	-	2/9	to	2/6	per lb.
Camphor (Chinese Crude)	-	2/8	to	2/6	,,
,, (Japanese, Refined)	-	2/4	to	3/3	,,
Cinnamon (Ceylon leaf)	-	5/6			,,
Citronella (Ceylon)	-	1/7			,,
,, (Java)	-	2/5	to	2/4	,,
Clove (90 to 92%)	-	6/-	to	5/10	,,
Lemon grass (Cochin)	-	3/6	to	3/7	,,
Lime (West Indian, distilled)	-	27/-	to	30/-	,,
Patchouli (Penang)	-	23/-	to	24/6	,,
Vetiver (Bourbon)	-	45/-	to	42/-	,,
,, (Java)	-	50/-	to	43/-	,,

Spices.

Capsicums (East Indian)	40/-	to	45/-	per cwt.
„ (Nyassaland)	60/-	to	70/-	„
Chillies (Zanzibar)	35/-	to	42/6	„
„ (Nyassaland)	50/-	to	65/-	„
„ (Japan)	95/-			„
Cinnamon (Ceylon)	2/-			per lb.
Cloves (Zanzibar)	11d.	to	9d.	„
„ (Penang)	2/-	to	2/2	„
Ginger (Japan)	55/-			per cwt.
„ (Jamaica)	60/-	to	90/-	„
Mace (Bombay & Penang)	3/10	to	4/-	per lb.
Nutmegs (Singapore & Penang)				
110's	1/10			„
80's	2/2			„
64—57's	2/5	to	2/6	„
Pepper (Singapore black)	9¾d.	to	11d.	„
„ (Singapore white)	1/4	to	1/4½	„

Drugs.

Chaulmoogra (genuine)	2/9			per lb.
Ipecacuanha (Rio)	14/-	to	14/6	„

Natural Dyes & Extracts.

Annatto	5d.	to	4d.	„
Aambier (block)	40/-			per cwt.
„ (cube)	65/-			„

Gums & Resins.

Damar (Singapore)	35/-	to	155/-	„
„ (Batavia)	125/-	to	155/-	„
Dragon's Blood (reed) Nom	£15	to	£20	„
Gutta percha (genuine)	2/9			per lb.
„ (Sarawak)	3/-	to	4/-	„
„ (Siak reboiled)	1/5			„

Fibres.

Cotton (American G. O. to Mid)	6.58d.	to	9.93d	„
„ (Egyptian Sakellarides G. F. to Fine)	15.15d.	to	18.65d.	„
Hemp (Manilla "J" Grade)	£40.10.0	to	£44.10.0	per ton.
„ (Mauritius)	£39	to	£42	„
„ (New Zealand)	£33.10.0	to	£36.10.0	„
„ (Sisal)	£22	to	£48.10.0	„
Kapok (Indian)	1/1	to	1/1½	per lb.
„ (Java)	1/4¾	to	1/5	„

Foodstuffs.

Arrowroot (Natal)	-	8d.	to 9d.	per lb.
Cocoa (Ceylon Plantation)	-	70/-	to 85/-	per cwt.
Coffee (Malay Plantation)	-	95/-	to 130/-	,,
,, (Liberian)	-	100/-	to 105/-	,,
Sago (Pearl)	-	28/-		,,
,, (Flour)	-	17/6	to 18/6	,,
Tapioca (Singapore, flake)	-	2½d.	to 3d.	per lb.
,, (flour)	-	18/-	to 22/-	per cwt.
,, (seed pearl)	-	17/6		,,

Chemicals.

Acetic Acid (glacial)	-	£65.10.0		per ton.
,, (80% con)	-	£37	to £39	,,
Acetone	-	£80		,,
Ammonia (.880)	-	£21		,,
Aalcium Acetate (grey)	-	£17.10.0		,,
Aitric Acid	-	1/3	to 1/3⅜	per lb.
Formic Acid (85%)	-	£50	to £52.10.0	per ton.
Formalin (40% vol.)	-	£40		,,
Lime Juice (Conc) nom.	-	£20		,,
Sodium bisulphite (60 to 62%)	-	£15		,,
Sodium Sulphite (anhydrous)	-	£14		,,
Sulphate of Ammonia	-	£10.15.0	to £12	,,
Wood Creosote (Unrefined)	-	2/9		per gal.

The market for oils and oil cakes shows a general decline since ast quarter, most commodities being a quiet market. Palm oil (Lagos) made a sharp decline in September owing to heavy arrivals, but rapidly recovered. Supplies of palm kernel cake continue short with a favourable effect on the price. The prices generally for cakes have been steady.

Essential oils show minor fluctuations in most cases with the exception of Patchouli which is scarce and dearer.

Gambier shows a further decline.

American cotton has further slumped, while Egyptian has firmed during the quarter.

The market for fibres continues good ; New Zealand hemp alone being an easier market.

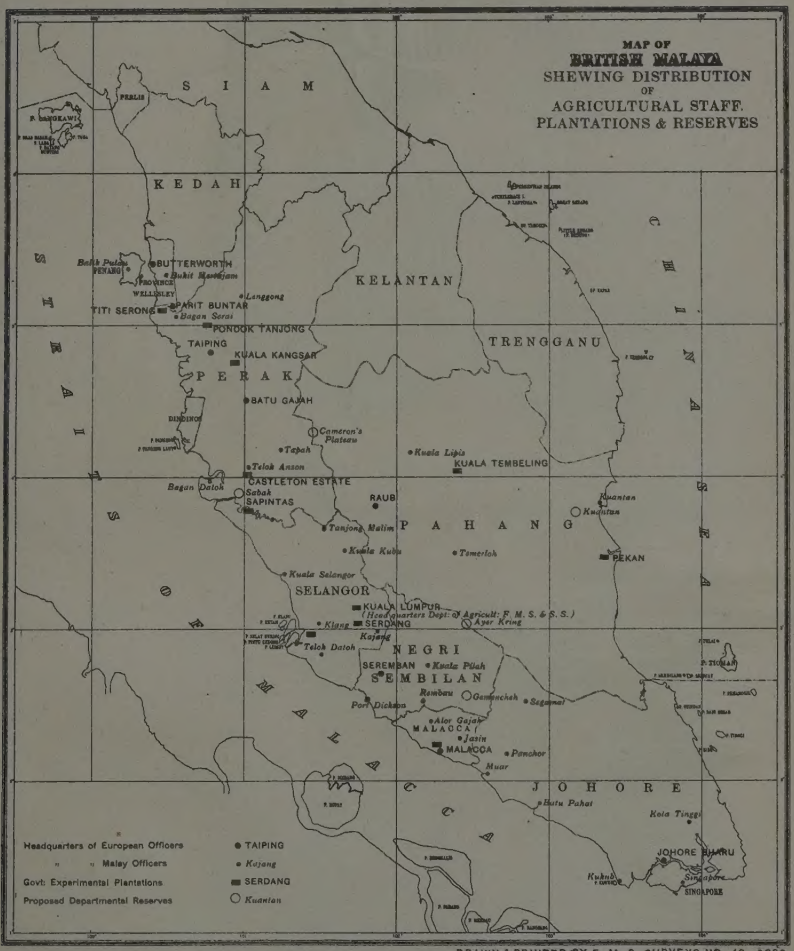
Food stuffs are steady, but quiet. Coffee and Cocoa have fallen back slightly, and there is a lower market for tapioca of all grades.

Chemicals continue a toneless market due to the unsettled industrial situation.

Note.—The above market price list is merely intended to indicate the trend of prices over the period under review. The list is based on various issues of the following journals published during the third quarter of 1926 :—

Lewis and Peat Monthly Prices Current : Lewis and Peat, West Indian, Central American and Brazilian Monthly Market Report ; Tropical Life ; British Trade Journal ; Fertilisers and Feeding Stuffs Journal ; Chemist and Druggist ; Chemical Trade Journal ; Chemical Age ; Perfumery and Essential Oil Records.

Received for publication 9th November, 1926.



DRAWN & PRINTED BY F. M. S. SURVEYS NO. 49 - 1926.